Vadose Zone Transport Field Project

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At the Hanford waste-storage facility near Richland, Washington, elevated concentrations of chromate, technetium, tritium, and nitrate have recently been found in the groundwater beneath the site. In collaboration with PNNL, Idaho National Engineering Laboratory, and LBNL; several universities; and private industry, we are working to mitigate the risk from accelerated transport of contaminants through the vadose, or unsaturated, zone. This large consortium has been asked to address this problem because recent characterization efforts, coupled with simplified transport modeling, have not been able to predict these observed contaminant plumes. (Problems with earlier research on this subject may be the failure to account for the heterogeneous nature of the unsaturated zone sediments.) We are obtaining data from uncontaminated sites around Hanford to support development and refinement of conceptual models and to facilitate calibration of numerical models of water flow and contaminant transport through Hanford's heterogeneous unsaturated zone. Los Alamos is the lead for analyzing test results from the tracer field experiments. We also will evaluate new ways to characterize changing conditions in the unsaturated zone, particularly in relation to currently undetectable high-risk contaminants.

Environmental Restoration at the Nevada Test Site (NTS)

Performance Assessment for the Great Confinement Disposal Boreholes at Area 5

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Disposing of classified transuranic (TRU) waste poses a challenge because it must be buried in a limited-access classified area and is not currently accepted at the recently opened Waste Isolation Pilot Plant in Carlsbad, New Mexico. Classified TRU waste was buried in large-diameter boreholes at a classified area withn the Area 5 radioactive waste management facility from 1984 to 1988. In collaboration with SNL, the lead DOE contractor, we have assisted with completing the final version of a DOE-mandated performance assessment of four boreholes containing classified TRU waste at Area 5. We investigated several significant technical issues: subsidence/flooding models for the 10,000-year compliance interval; moisture movement and radionuclide transport in unsaturated alluvium; and the impact of coupled flow and biointrusion processes with respect to upward radionuclide releases, from the buried waste inventory to the surface. DOE Headquarters developed review criteria for assessing the performance assessment and assembled a team to evaluate our results. The review is scheduled for January 2001.

Studying Radionuclide Transport from an Underground Nuclear Test

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At Pahute Mesa, a small amount of plutonium (Pu), previously considered immobile, was recently detected in two aquifers 1.3 km southwest of its source, the Benham underground nuclear test site. To further study this Pu movement, we are using the Los Alamos computer code FEHM to simulate transient, multiphase, multidimensional, nonisothermal flow, as well as to simulate the simultaneous transport of multiple chemically reactive and interacting solutes. We included both the complicated regional hydrostratigraphy and the conditions in the chimney and puddle glass in this model.

Our results indicate that the combination of the high-temperature puddle glass and increased permeability in the chimney provided sufficient conditions to establish and maintain a groundwater thermal circulation cell, which could have been the mechanism for solute and colloid transport up the chimney to the welded-tuff aquifer. Other variables we considered in the model were the fractures in the welded-tuff aquifer, matrix diffusion and sorption, sorption onto fractured minerals, and Pu-colloid reactions.

We found that, when limited to equilibrium conditions, Pu travel times are underestimated when compared to the field observations. However, when experimentally determined kinetic rates for Pu-colloid sorption are used, the model simulates the arrival of a small amount of Pu. This research is part of a multi-institutional project on assessing groundwater flow and radionuclide transport at NTS on a much larger scale. Our models, and other specific studies, are being embedded in a larger subregional flow model, covering approximately 80 square kilometers. The next stage will be abstraction of information from the high-resolution process-level models like ours into a format suitable for simulation transport on the subregional model.

Geological Characterization for the Underground Test Areas Project

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We are characterizing the NTS areas in which underground tests were conducted between 1951 and 1992. Using mineralogic, petrographic, and chemical data from rocks in this test area, we have developed a geological structural block model for the entire southwest Nevada volcanic field, and we update the model as new information becomes available. This model provides the basis for a majority of the regional and local groundwater flow models of NTS. We are also characterizing the alteration products that make up tuff-confining units at the site (determining the lateral and vertical changes in the physical/hydraulic and chemical/sorptive properties). Using mineralogic data from drill holes, we are mapping the content and distribution of the alteration products. These activities also support several Los Alamos hydrology experiments on this subject.

Regional Groundwater Flow and Transport Modeling of the Underground Test Area at the Nevada Test Site (NTS)

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The DOE/Nevada Operations Office conducted underground nuclear tests at NTS from 1951 to 1992, and groundwater at in the area has been contaminated as a result (300 million curies deposited underground; 130 curies deposited in or near the water table). The DOE is concerned about the possibility that some radionuclides may migrate off the NTS in the future, particularly from the western Pahute Mesa corrective action unit. As science advisor to the Assistant Manager for Environmental Management at the NTS, I work with researchers on special topics of concern. At present, we are working on alternative models of the geologic framework of Frenchman Flat and Pahute Mesa, probabilistic modeling codes that can be coupled to the flow-and-transport models to evaluate and potentially reduce total system uncertainty, and decision tools to prioritize data gathering and model assessments.